Data Communication and Net-Centric Computing

COSC 1111/2061/1110

Lecture 8

Medium Access Control Methods & LAN

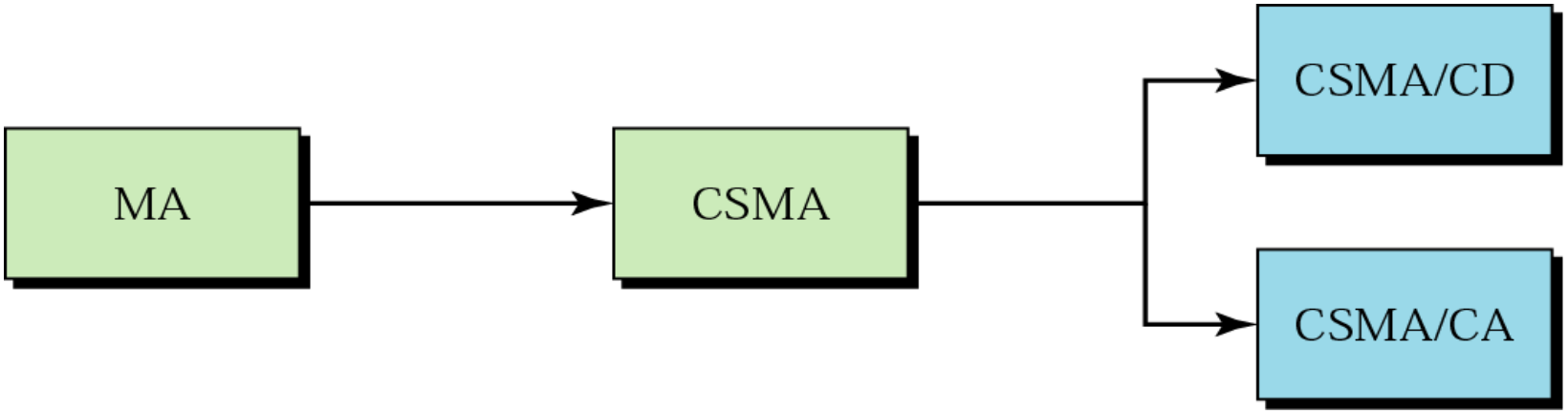
Lecture Overview

- During this lecture, we will
  - Look at several Multiple Access Control methods
  - Introduce ALOHA
  - Introduce CSMA
  - CSMA/CD
  - Network components
- Recommended reading
  - Chapter 15, 16 (Stallings, 8th Ed.)

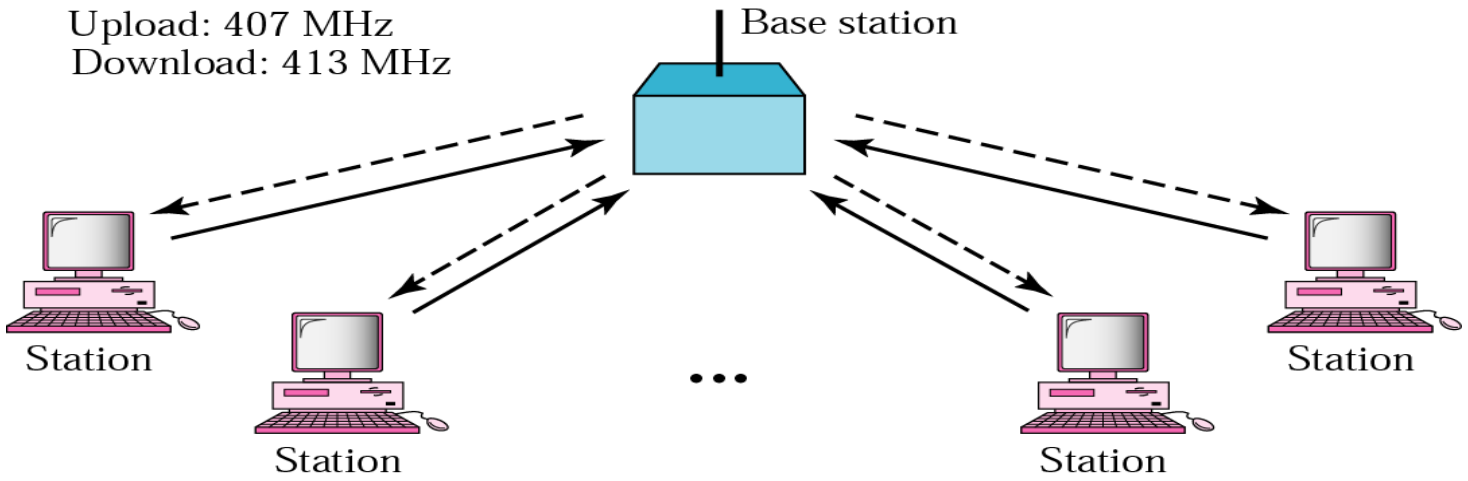
Ethernet (CSMA/CD)

- Carriers Sense Multiple Access with Collision Detection
- Xerox - Ethernet
- IEEE 802.3 MAC
  - Random Access
    - Stations access medium randomly
  - Contention
    - Stations content for time on medium

Evolution of random-access methods

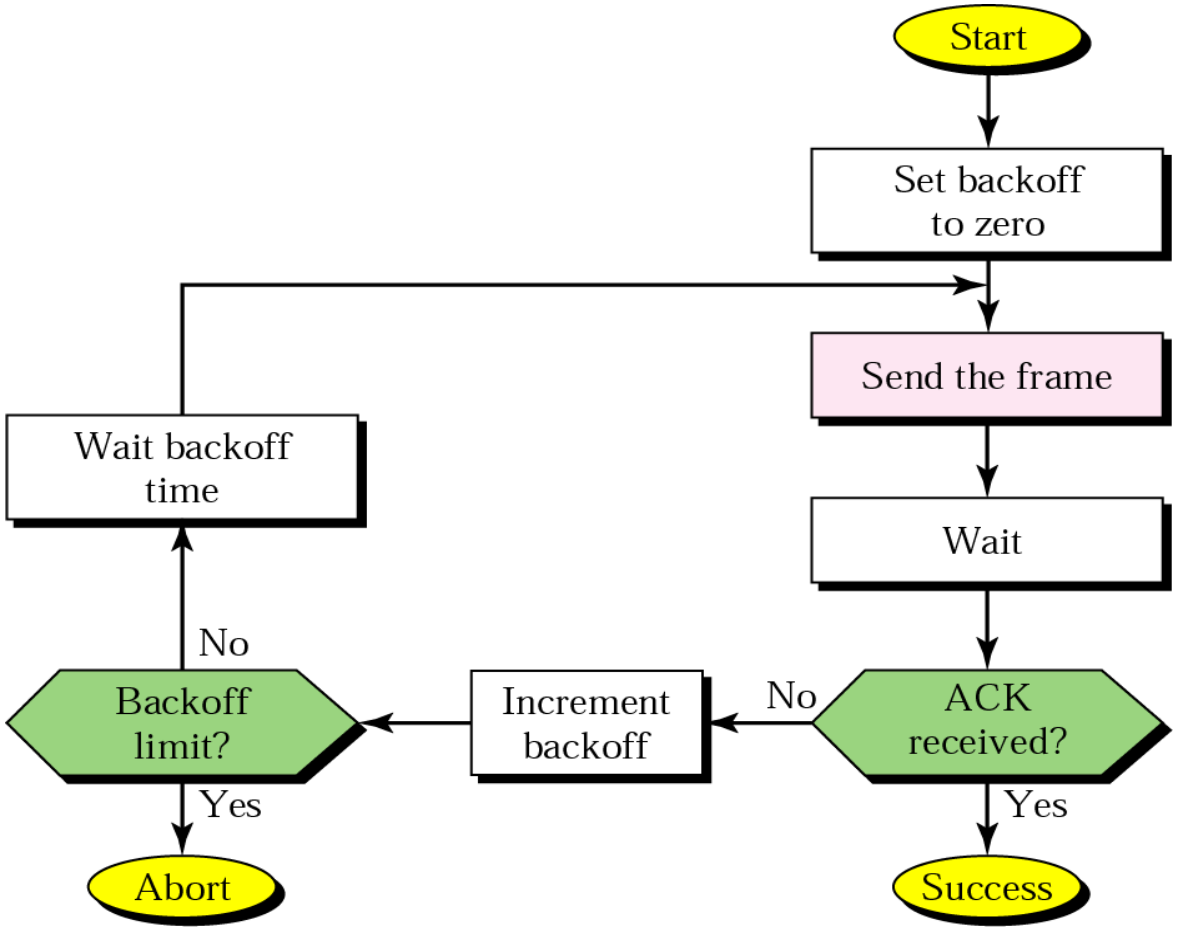


ALOHA Network



- Packet Radio
- When station has frame, it sends
- Station listens (for max round trip time) plus small increment
- If ACK, ok else retransmit
- If no ACK after repeated transmissions, gives up
- Frame damaged by noise or by another station transmitting at the same time (collision)
- Overlap of frames causes collision
- Max utilization about 18%

ALOHA Protocol



What is this backoff?

- Any station can send a frame
- If there is a collision, the frame needs to be sent again.
- To reduce the probability of collision the second time, the station waits – it *backs off*
- How much to wait? First time a little, more if a collision occurs again, and so on.

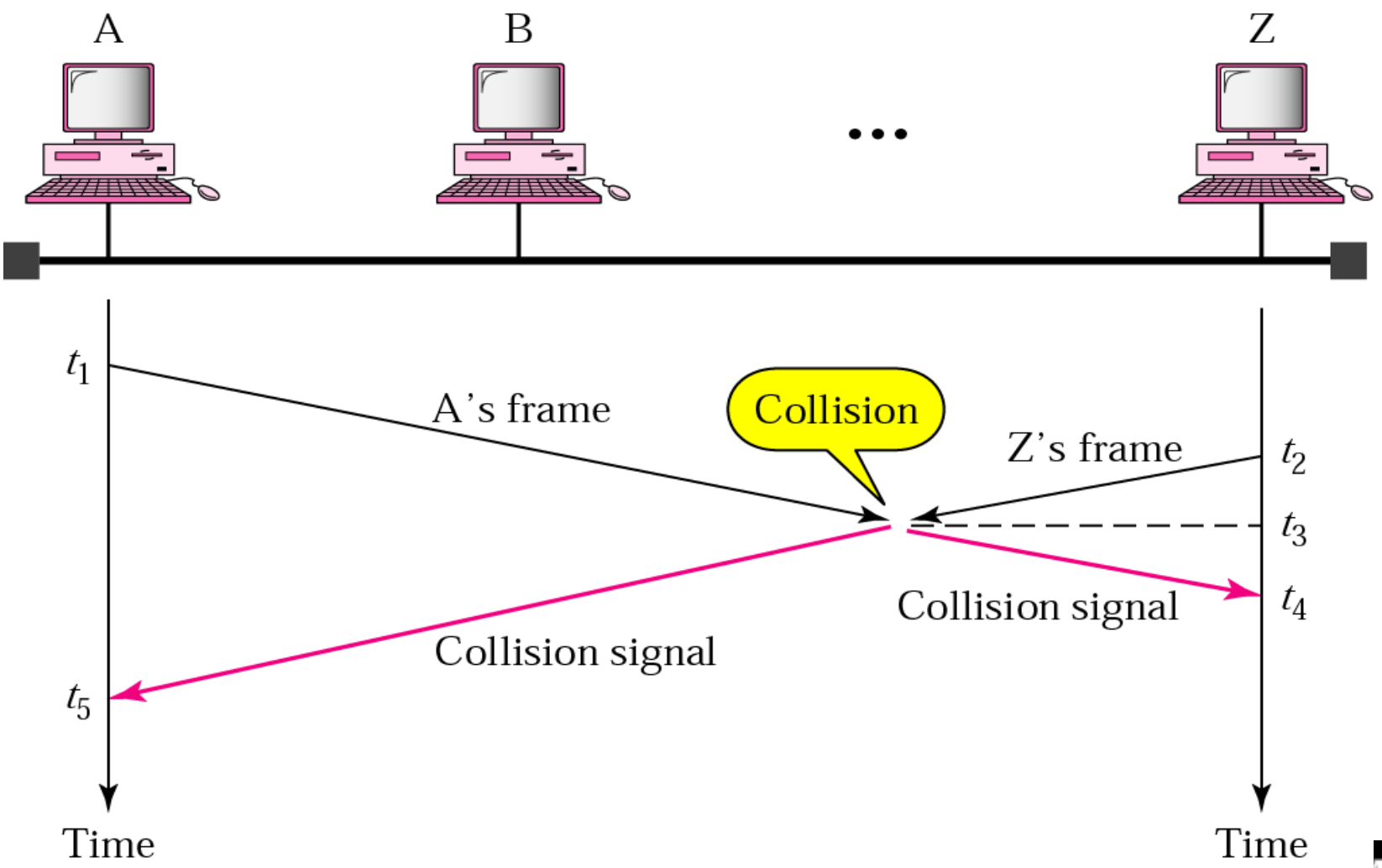
Slotted ALOHA

- Time on channel divided into uniform slots
- Size of slots equal the frame transmission time
- Need central clock (or other sync mechanism) to synchronize all stations
- Transmission permitted to begin only at a slot boundary
- Frames either miss or overlap totally
- Max utilization about 37%
  - Point to note
    - ALOHA and Slotted ALOHA – poor utilization

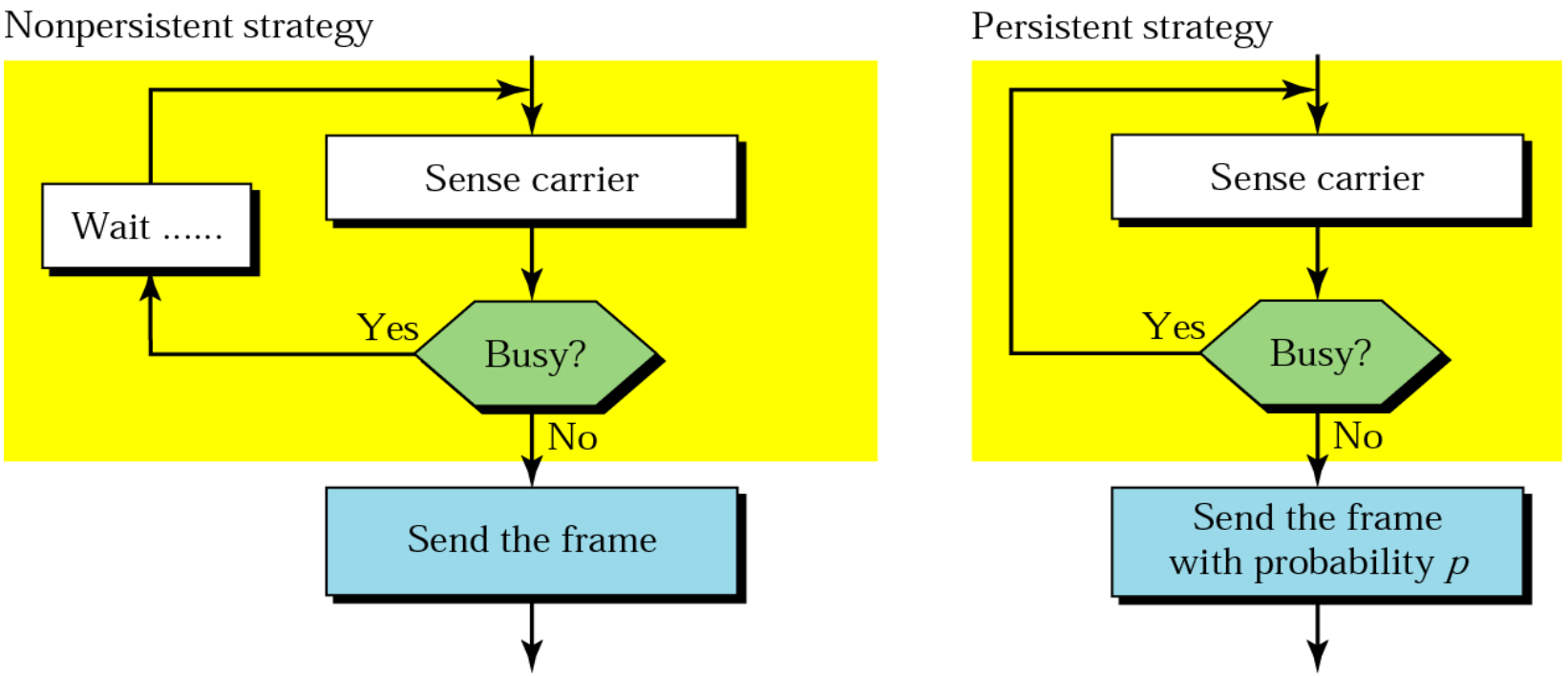
CSMA – listen before talk

- Why CSMA: to minimize the chance of collision (in ALOHA) increase performance.
- All stations know that a transmission has started almost immediately
- First listen for clear medium (carrier sense)
- If medium idle, transmit
- If two stations start at the same instant, collision.
- Wait reasonable time (round trip plus ACK)
- No ACK then retransmit
- Max utilization depends on propagation time (medium length) and frame length
  - Longer frame and shorter propagation gives better utilization

Collision in CSMA



Persistence Strategies



Nonpersistent CSMA

- Algorithm that specifies what station should do when medium is found busy
  - IEEE 802.3 – p-*persistent* technique – The rules

1. If medium idle, transmit; else next step
2. Medium busy, wait! Repeat step 1

- Random delays reduces probability of collisions
  - Two stations ready to transmit at same time when transmission in progress
  - If both stations delay same time before retrying, both will attempt to transmit at same time
- Capacity is wasted because medium will remain idle following end of transmission
  - Even if one or more stations waiting

Value of *p*

- Objective: Avoid instability under heavy load
- If large number of stations waiting to send

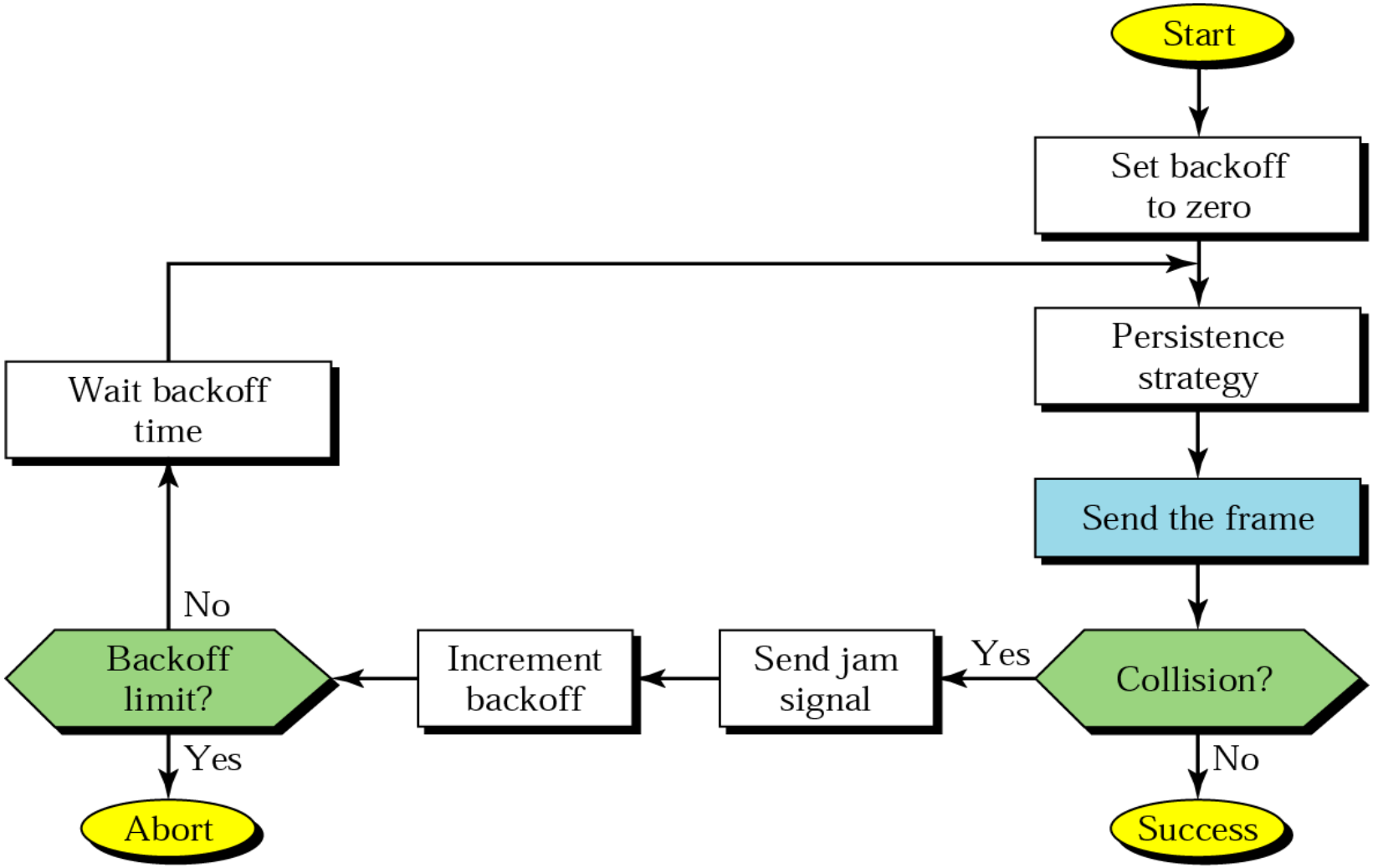
  -Repeated attempts to transmit - more collisions
- Retries compete with new transmissions
- Eventually, all stations trying to send
  - Continuous collisions; zero throughput
- If heavy load expected, *p* small
- However, as *p* made smaller, stations wait longer
- At low loads, this gives very long delays

CSMA/CD

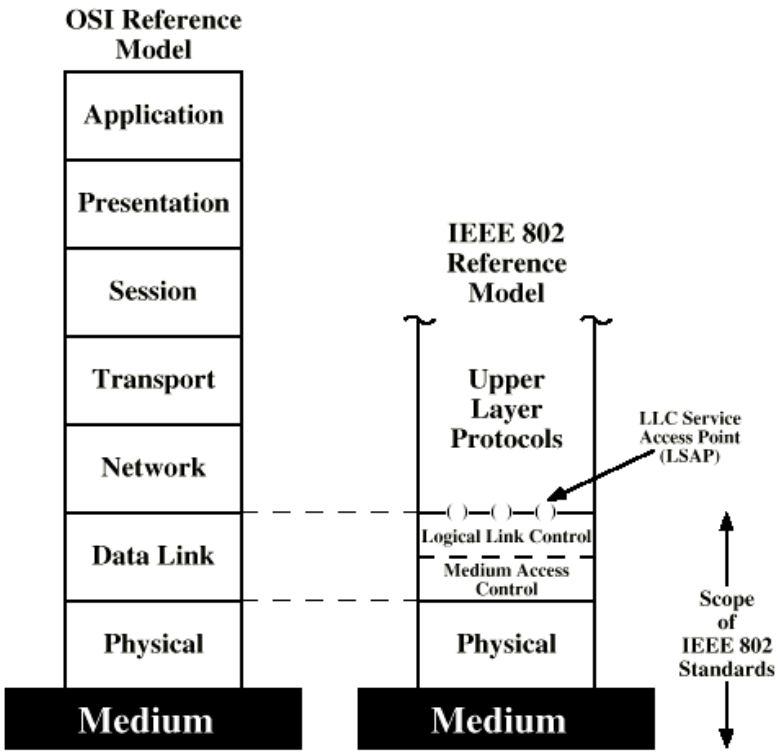
- With CSMA, collision occupies medium for duration of transmission
- Stations listen whilst transmitting

1. If medium idle, transmit, else step 2
2. If busy, listen for idle, then transmit
3. If collision detected, jam then cease transmission
4. After jam, wait random time then start from step 1

CSMA/CD Procedure

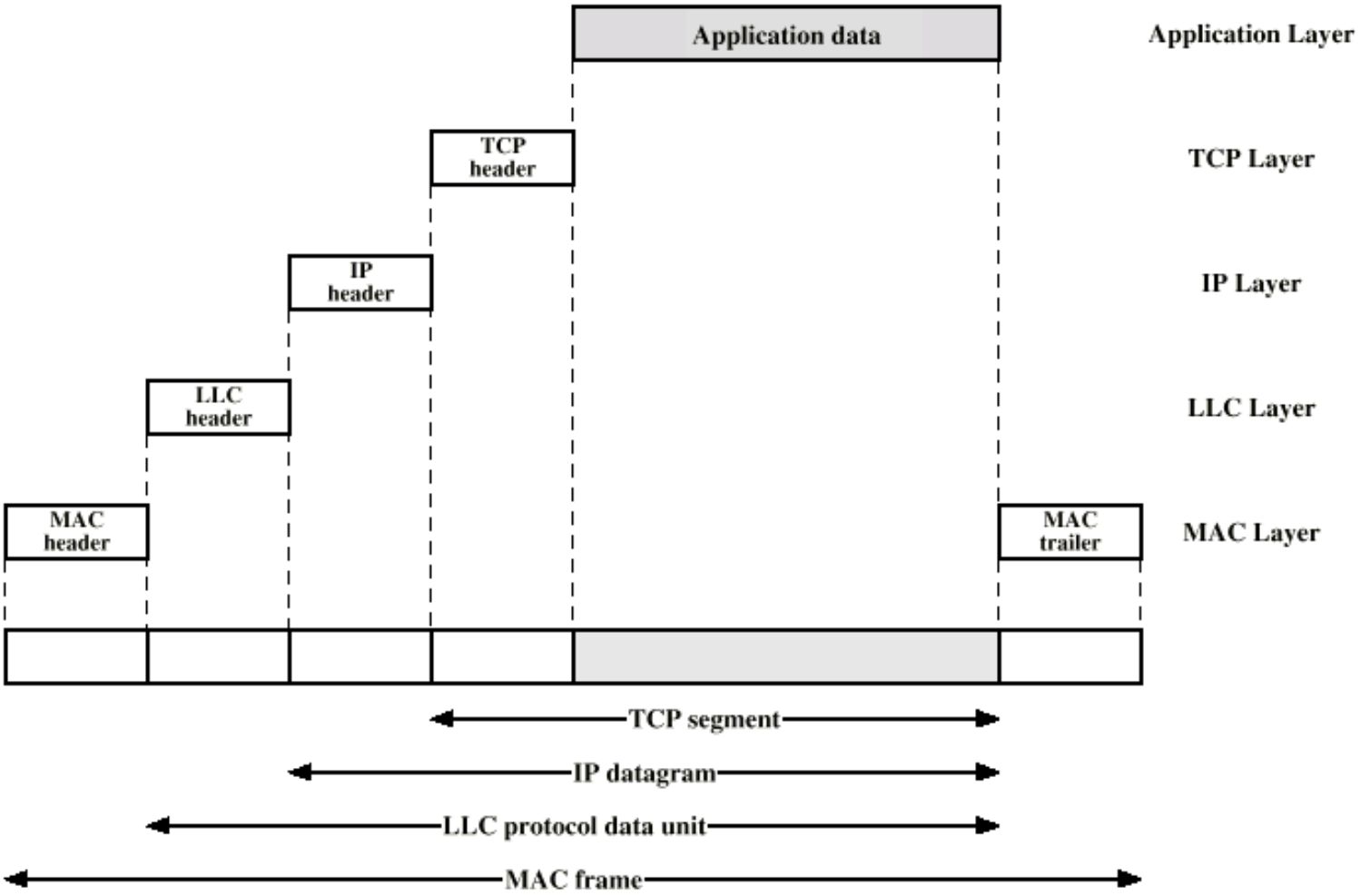


IEEE 802 v OSI and PL functions

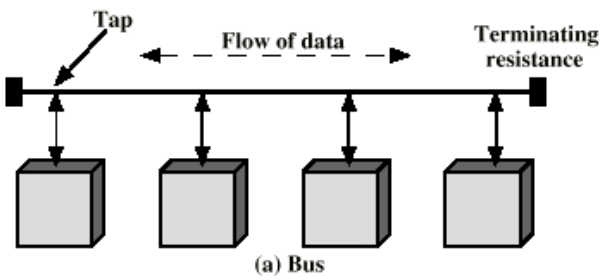


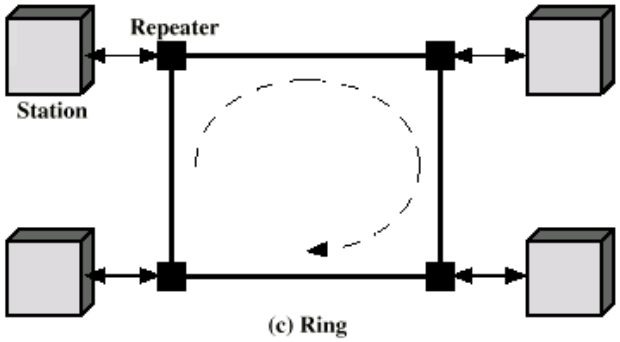
- Architecture developed by IEEE 802 committee (IEEE 802 reference model)
- Physical Layer (PL) functions
  - Encoding/decoding of signals
  - Preamble removal/generation
  - Bit transmission/reception
- Above PL – functions associated with providing service to users
  - Transmission – assemble data
  - Reception – disassemble frame
  - Govern access and provide interface

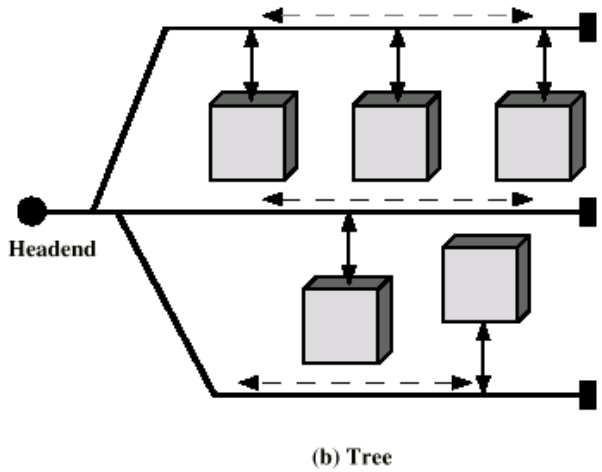
LAN Protocols in Context

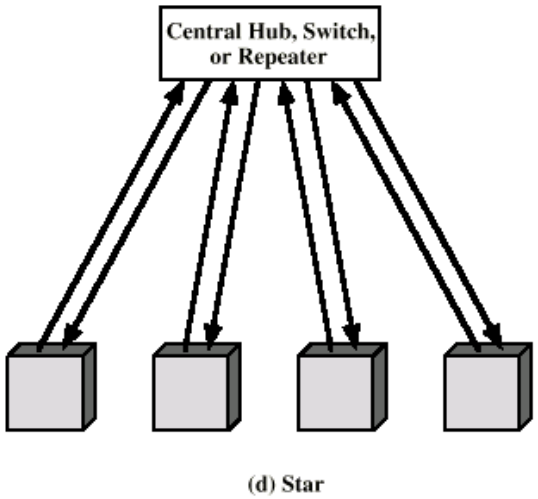


LAN Topology









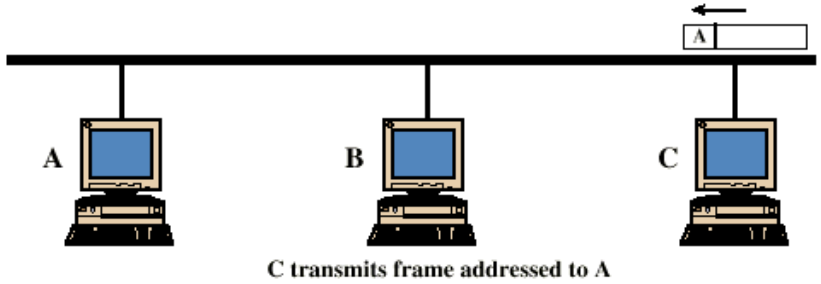
- LAN topology based on application and environment.
  - Bus topology
  - Tree topology
  - Ring topology
  - Star topology

Full Duplex Operation

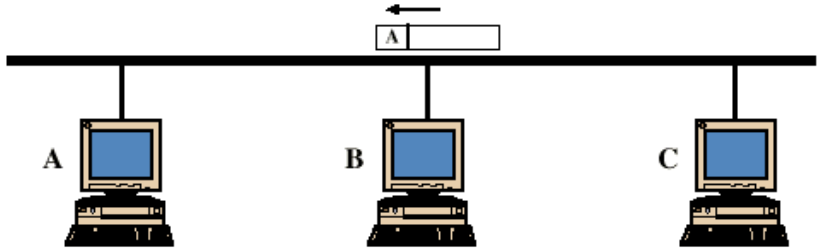
- Traditional (old) Ethernet half duplex
  - Either transmit or receive but not both simultaneously
- With full-duplex, station can transmit and receive simultaneously
- 100-Mbps Ethernet in full-duplex mode, theoretical transfer rate 200 Mbps
- Attached stations must have full-duplex adapter cards

Bus and Tree topology

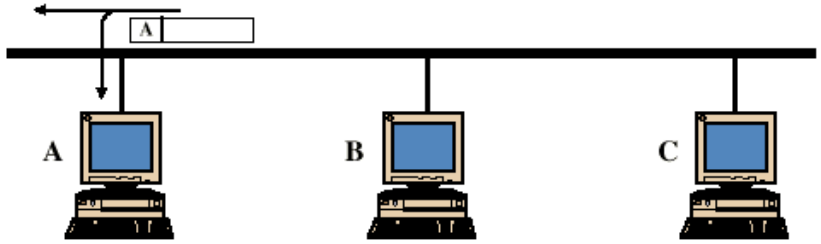
- Heard by all stations
  - Need to identify target station
    - Each station has unique address
- Full duplex connection - station and tap
  - Tap allows connection to cable
- Tree is an extension of Bus topology



C transmits frame addressed to A



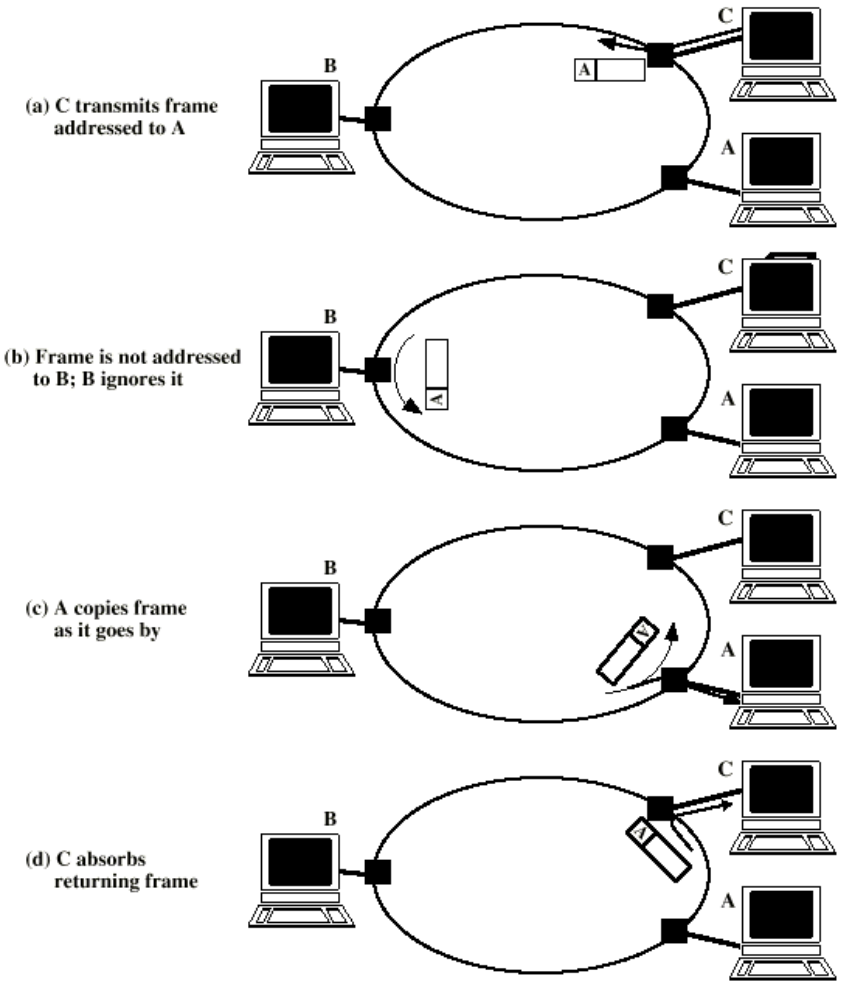
Frame is not addressed to B; B ignores it



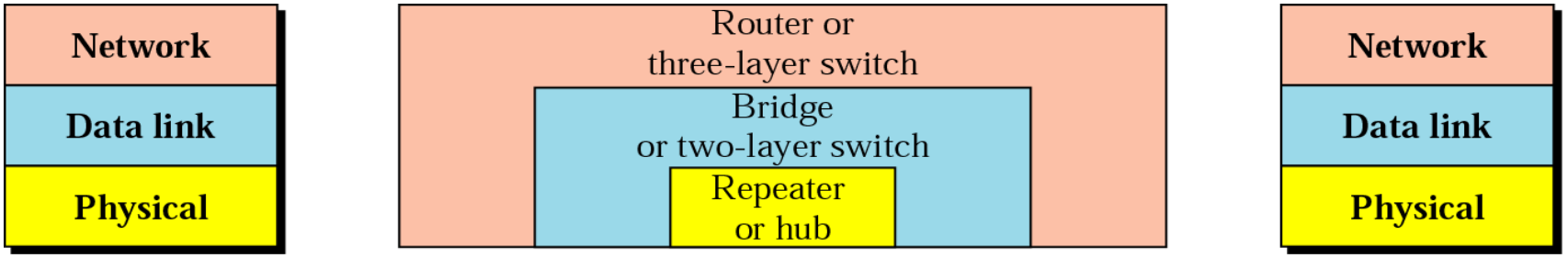
A copies frame as it goes by

Ring Topology

- Node to node in closed loop
  - Unidirectional
  - Circulate past all stations
- Node acts as repeater for other nodes' messages
- Media access control
  - Ensures that each station has a chance to insert their own data
  - Will not just pass only other nodes' messages

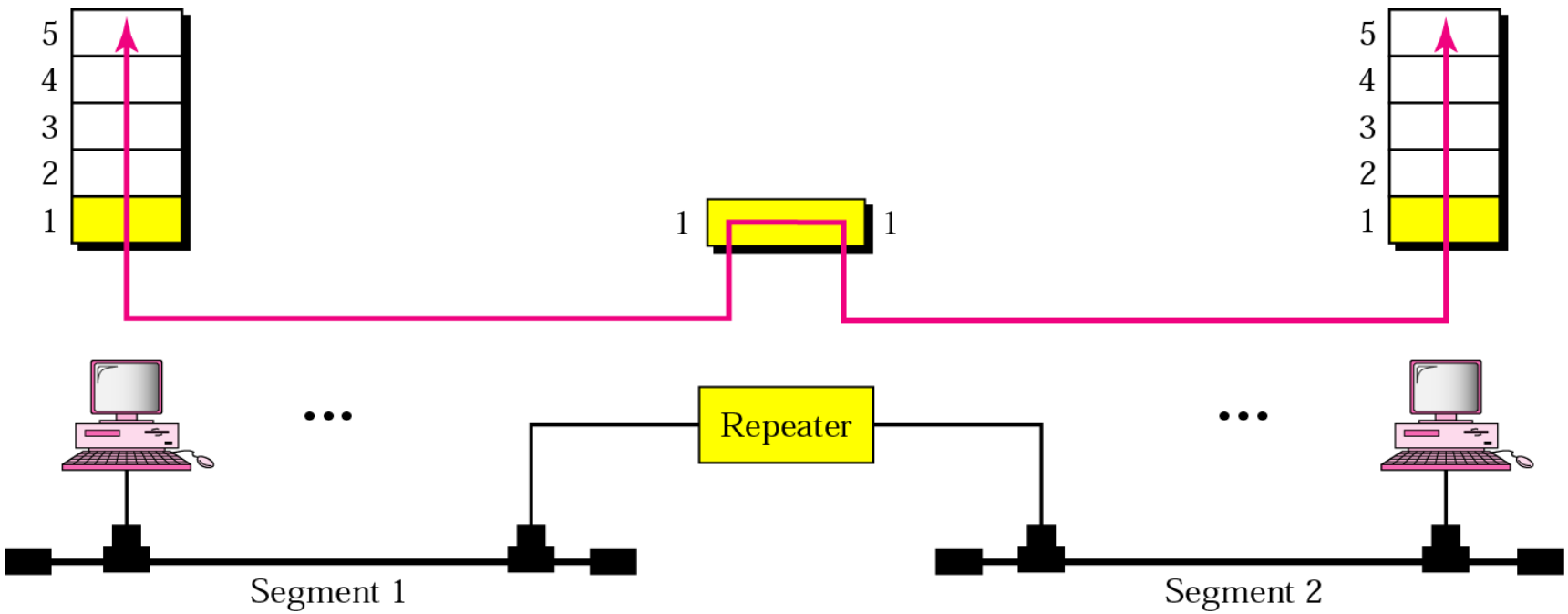


Connecting Devices



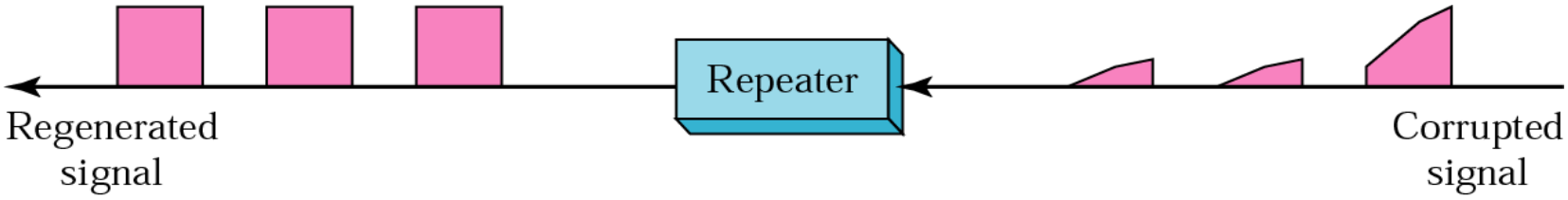
- Repeaters
- Hubs
- Bridges
- Two-Layer Switches

Repeaters

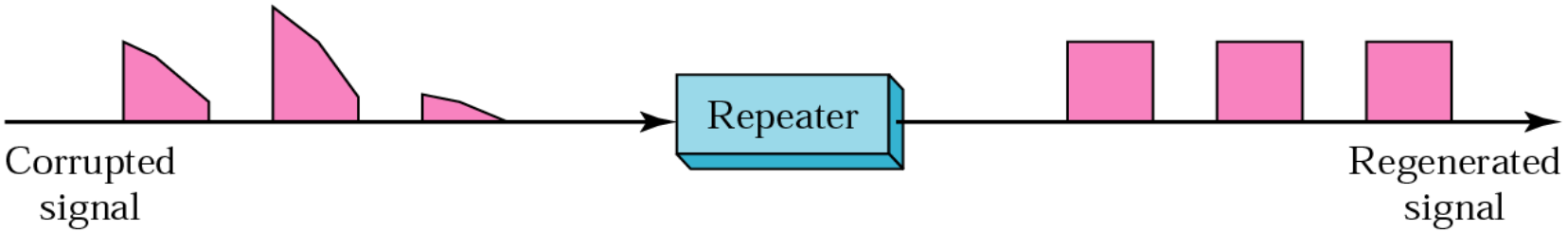


- A repeater connects segments of a LAN
- A repeater forwards every frame; it has no filtering capability

Function of a repeater



a. Right-to-left transmission.

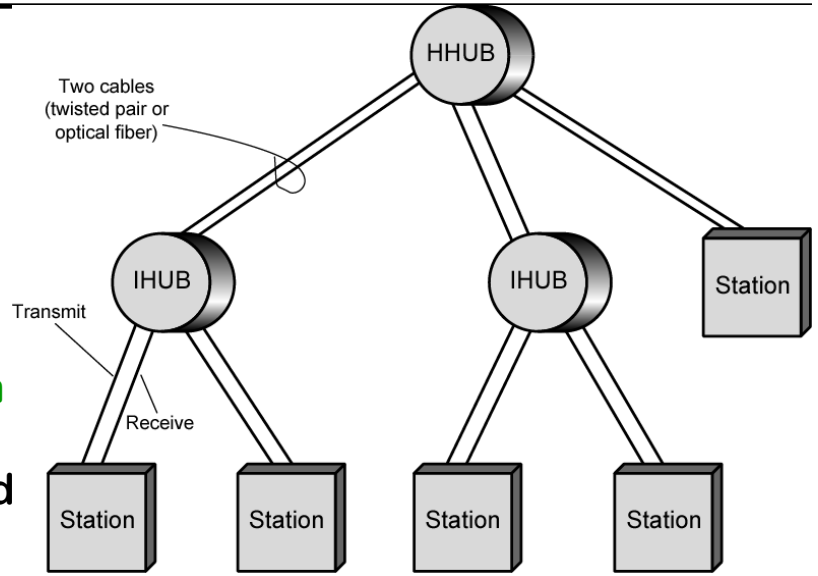


b. Left-to-right transmission.

- A repeater is a regenerator, not an amplifier

Hubs

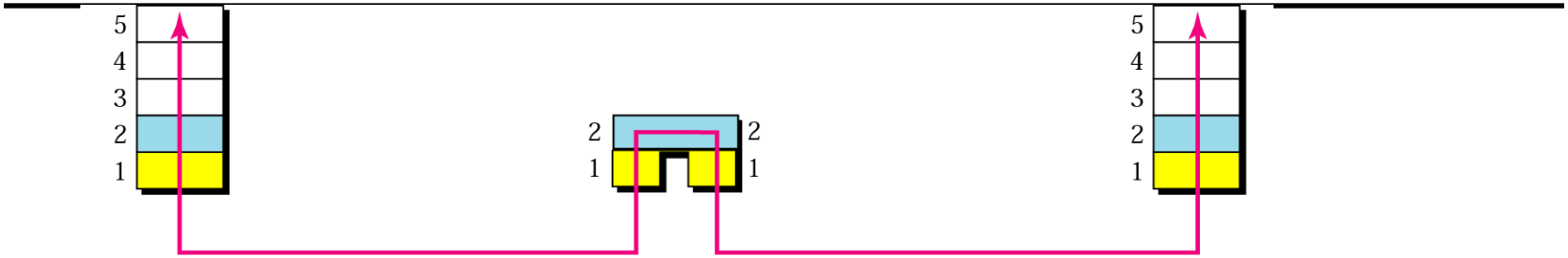
- Active central element of star layout
- Each station connected to hub by two lines
  - Transmit and receive
- Hub acts as a repeater
- When single station transmits, hub repeats signal on outgoing line to each station
- Line consists of two unshielded twisted pairs
- Limited to about 100 m
  - High data rate and poor transmission qualities of UTP
- Optical fiber may be used
  - Max about 500 m
- Physically star, logically bus
- Transmission from any station received by all other stations
- If two stations transmit at the same time, collision



Bridges

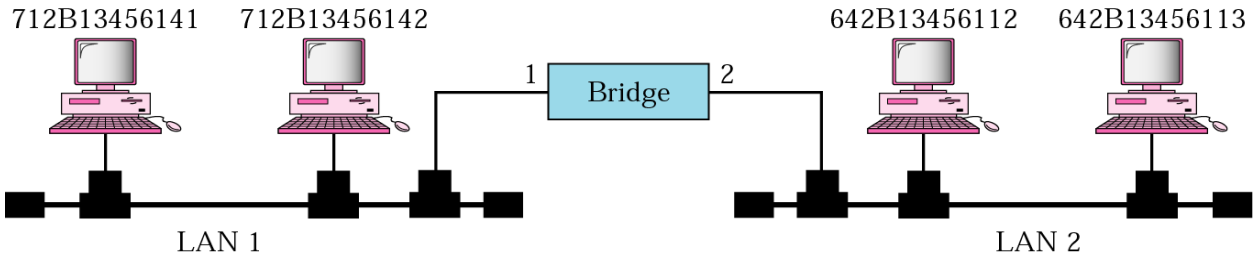
- Ability to expand beyond single LAN
- Provide interconnection to other LANs/WANs
- Use Bridge or router
- Bridge is simpler
  - Connects similar LANs
  - Identical protocols for physical and link layers
  - Minimal processing
- Bridge has filtering capabilities
- Router more general purpose
  - Interconnect various LANs and WANs

Bridge Operation



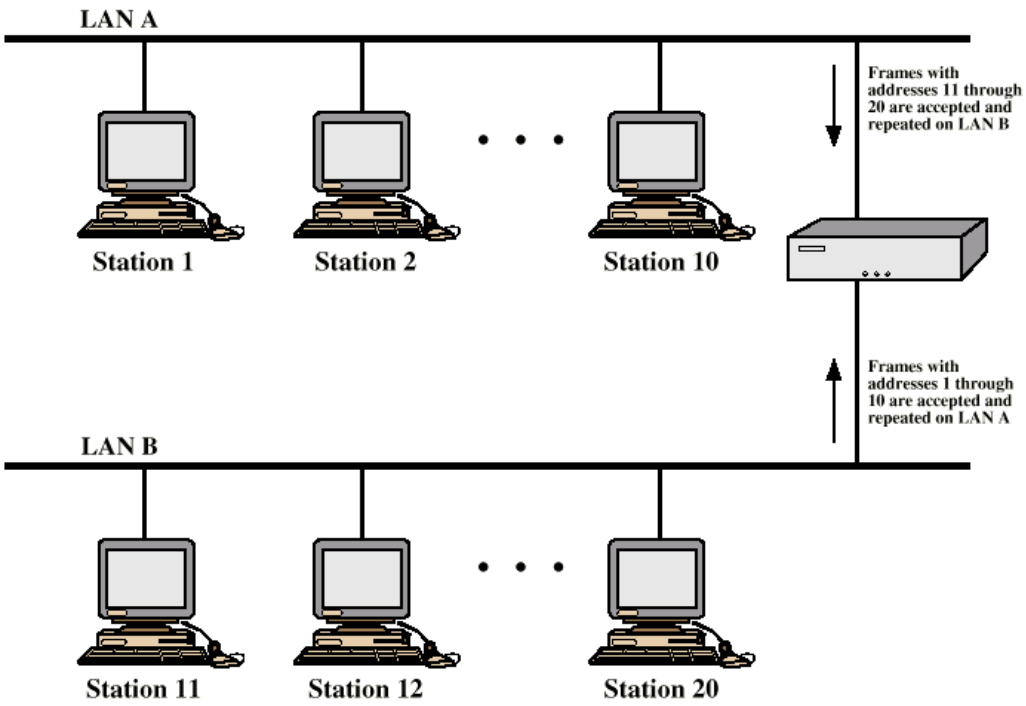
Address	Port
712B13456141	1
712B13456142	1
642B13456112	2
642B13456113	2

Bridge Table



- If frame for 712b13456142 arrives at port 1 the bridge consults table for departing port. So, it leaves through port 1
- Therefore no need for forwarding, the frame is dropped. **Result: LAN2 remains free of traffic.**
- If frame for 712b13456141 arrives at port 2, the frame is forwarded. **Result: Both LANs have traffic.**

Bridge Operation

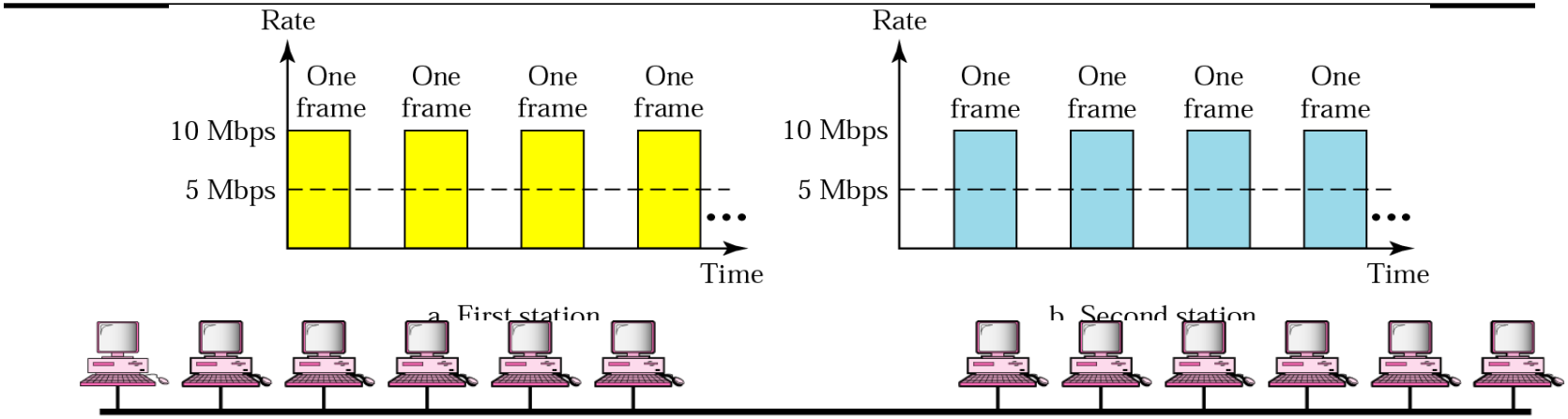


- Read all frames transmitted on one LAN and accept those address to any station on the other LAN
- Using MAC protocol for second LAN, retransmit each frame
- Do the same the other way round
- No modification to content or format of frame
- Enough buffer space to meet demands

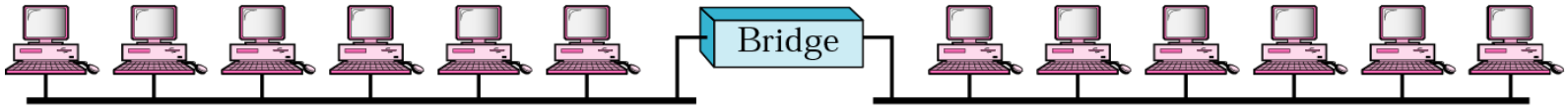
Why Bridge?

- Reliability
  - Partitioned into self-contained units
- Performance
  - Decreases with increase in number of devices
- Security
  - Improves security of communications
  - Different traffic needing different security
  - Different users different security level
- Geography
  - Devices clustered in different locations

Bandwidth Sharing



a. Without bridging

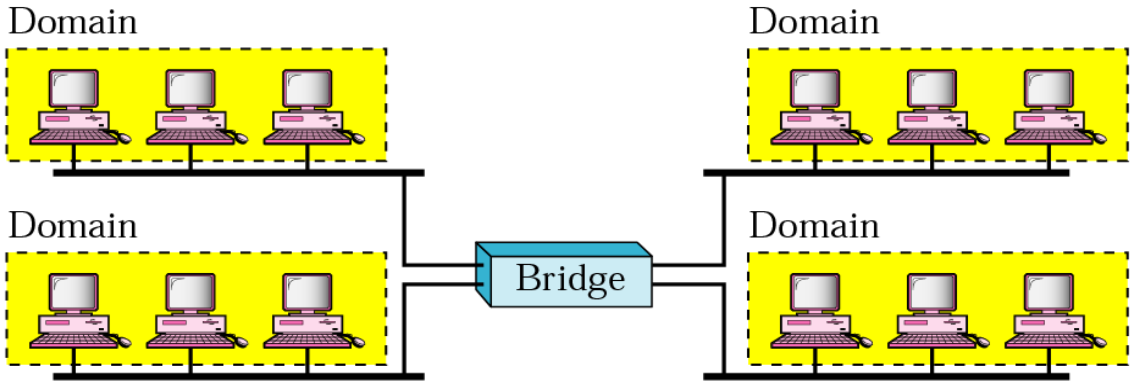


b. With bridging

- In an unbridged ethernet network, the total capacity (say 10 Mbps) is shared by all the stations.
- If two stations are sending frames, the probably alternate usage. On av. each station sends at the rate of 5 Mbps. If all stations sending, eff rate -> 10/12 Mbps.
- With bridging: 12 stations divided into two networks, each with 6.Under heavy load each station is theoretically offered 10/6 Mbps, not 10/12 Mbps.

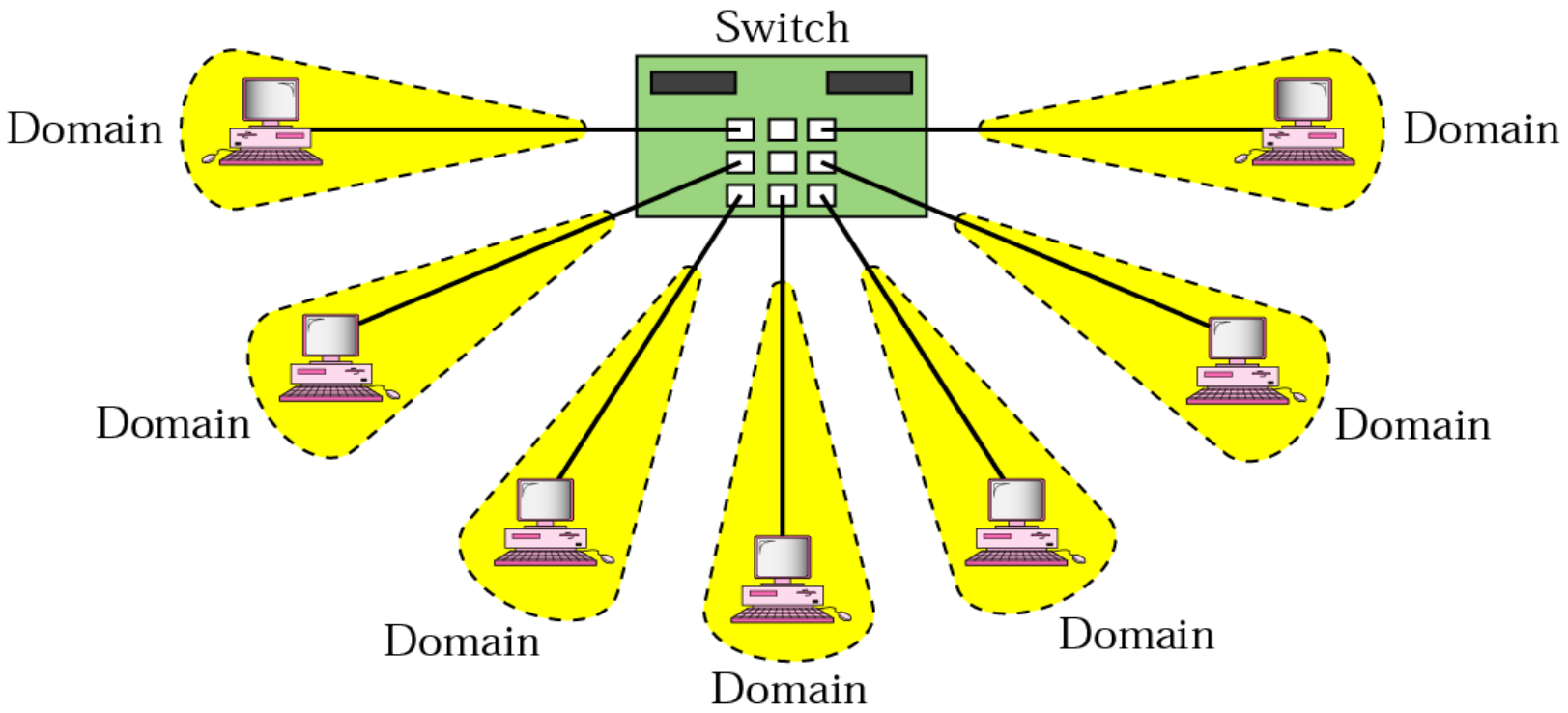
Collision domains in a nonbridged and bridged network

a. Without bridging



b. With bridging

Switched Ethernet

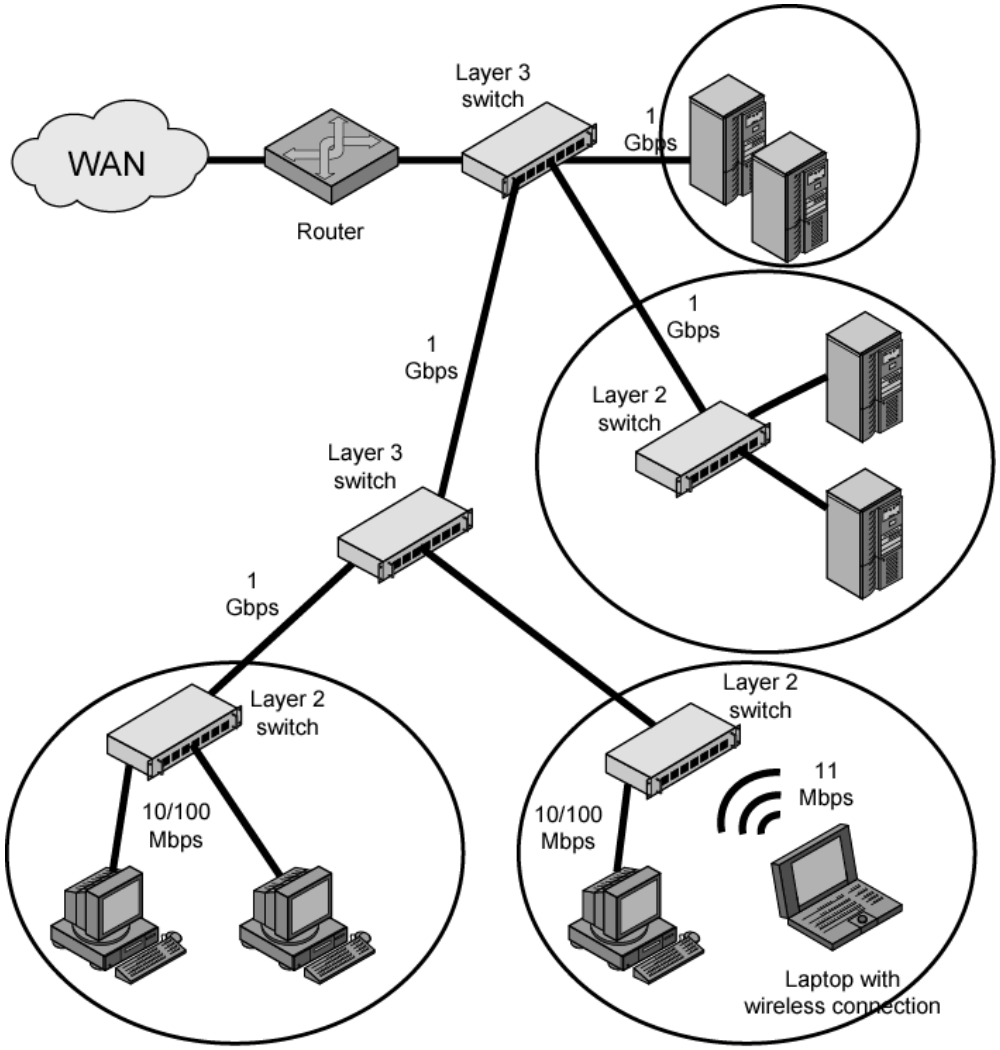


Layer 2 and 4 Switches

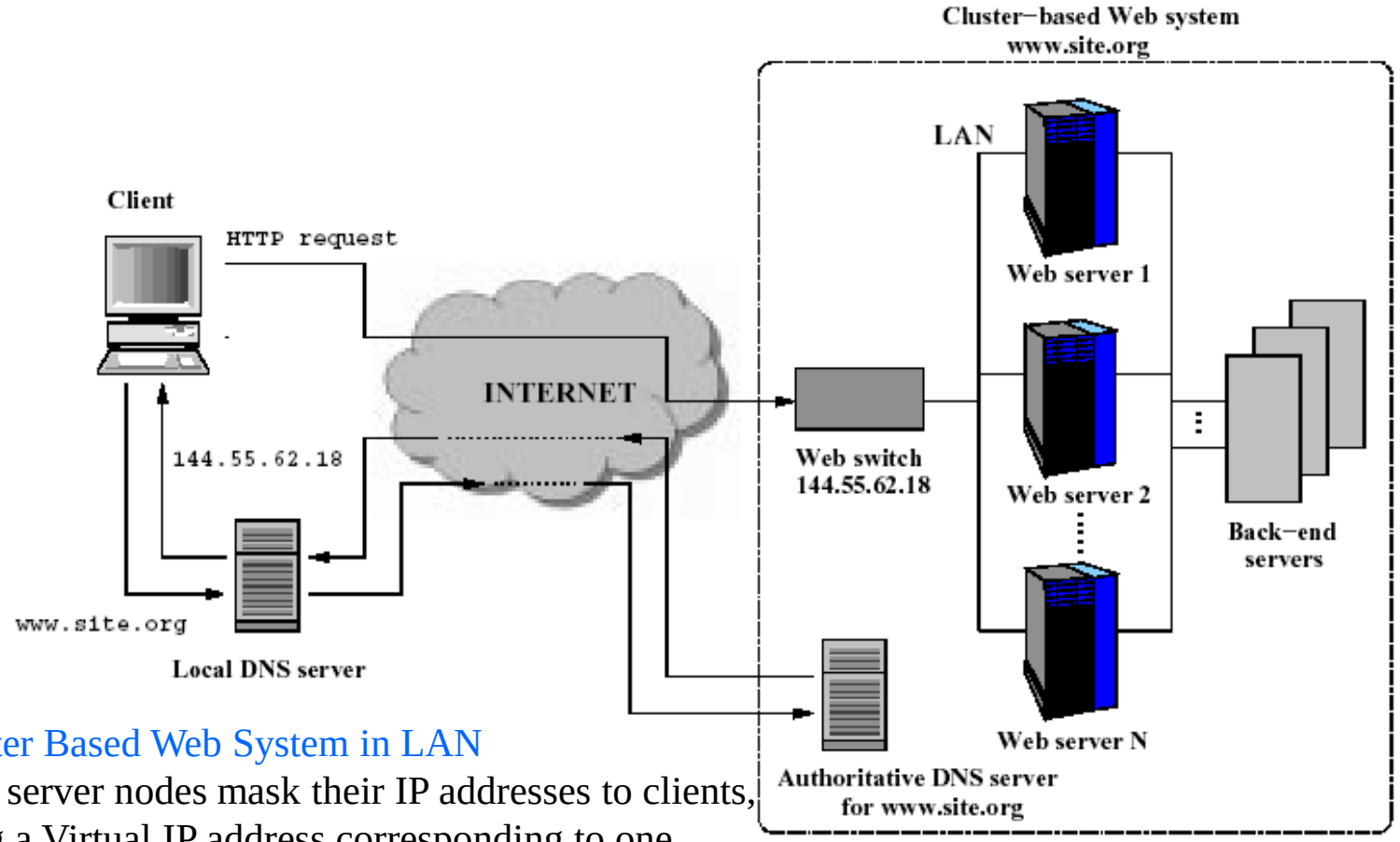
- Layer 2 switches operate using physical network addresses
- Switches operating at Layer 2 are very fast because they're just sorting physical addresses
- Are not very smart—that is, they don't look at the data packet very closely

- Layer 4 switches can use transport layer protocols to differentiate types of applications
- Use policies to direct traffic to different locations for load balancing.

Typical Large LAN Organization Diagram



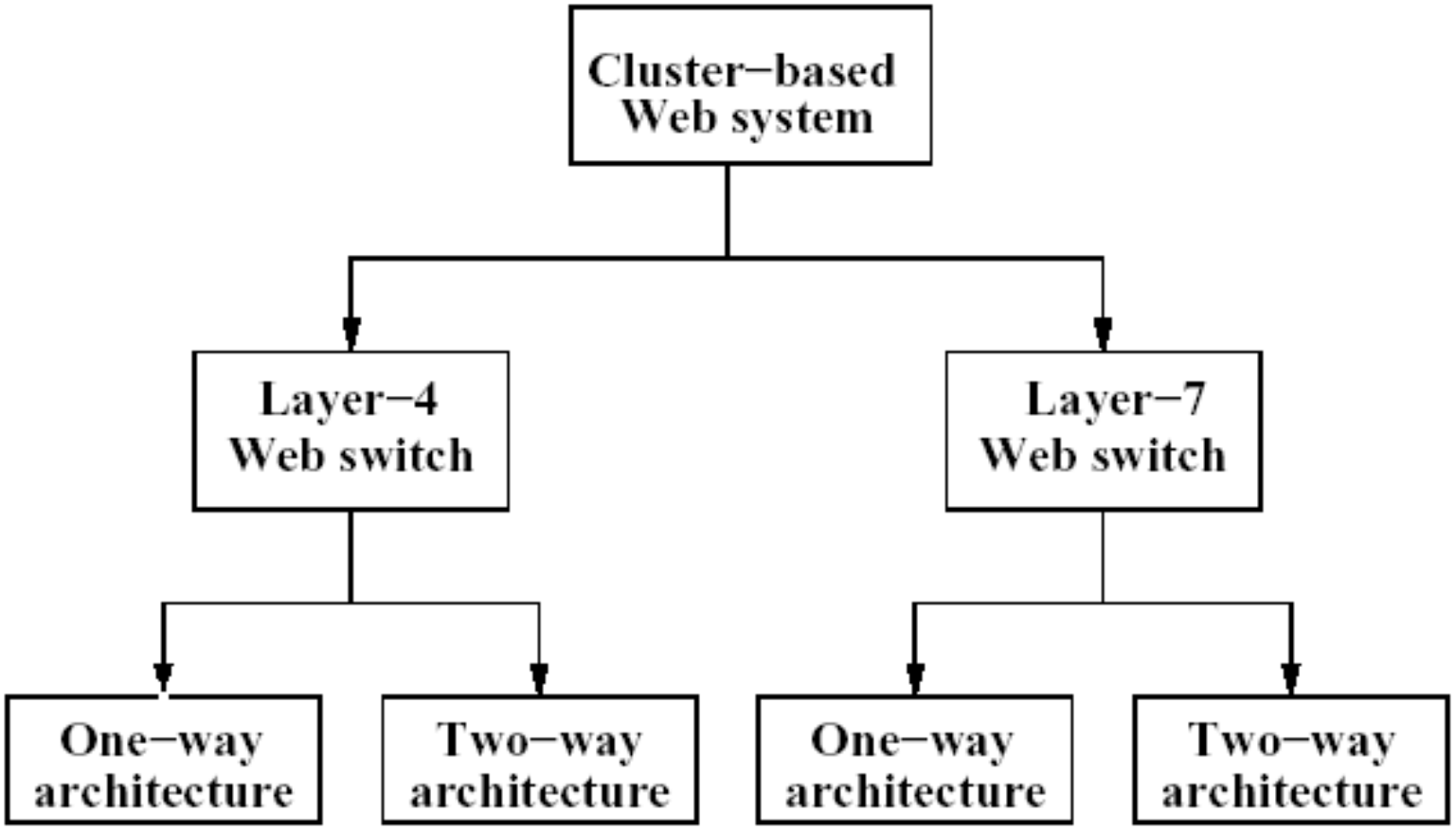
Cluster based LAN Architecture



Cluster Based Web System in LAN

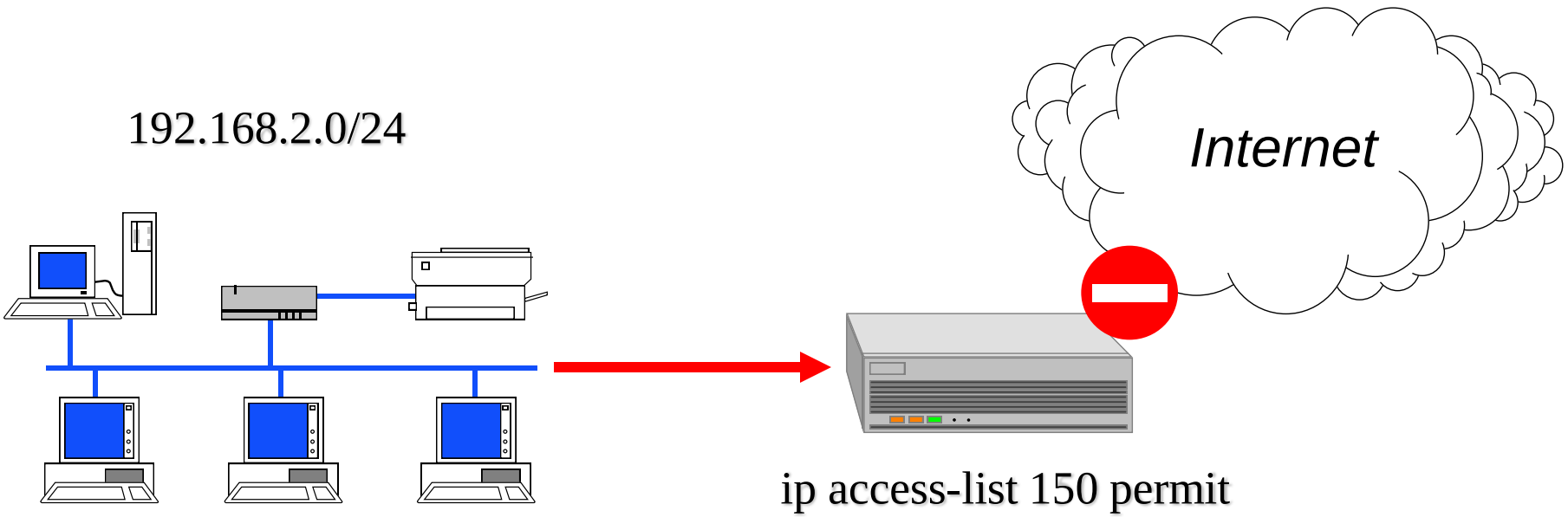
the server nodes mask their IP addresses to clients, using a Virtual IP address corresponding to one device (web switch) in front of the set of the servers – Web switch receives all packets and then sends them to server nodes

Cluster based architecture Taxonomy



Basic router filtering in LAN Prevent spoofing

- drop packets that have source address different from the assigned range

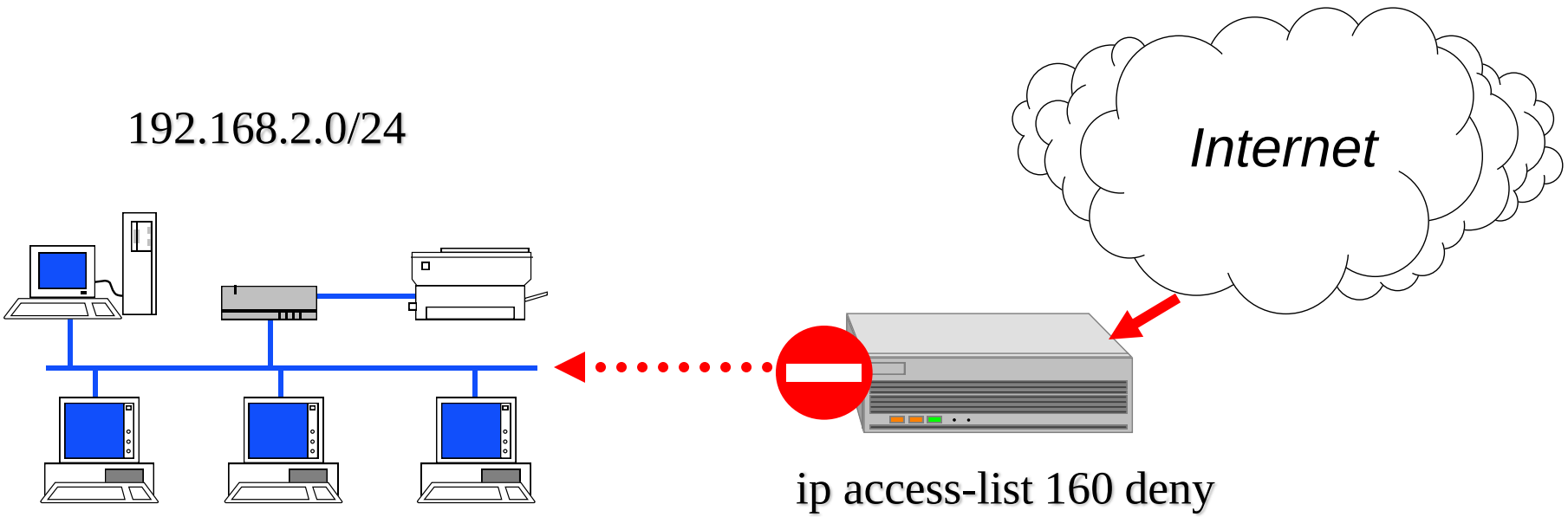


ip access-list 150 permit
192.168.2.0 255.255.255.0 any

Basic router filtering

Guard against IP address trust exploits

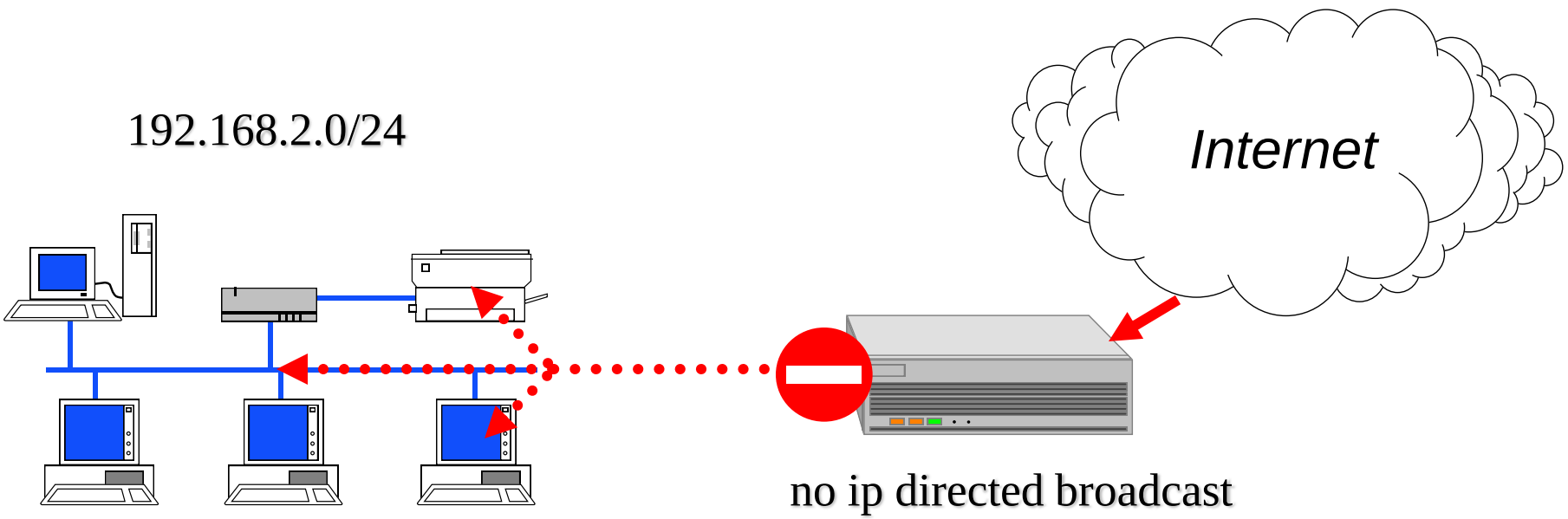
- drop packets with your network's source address coming from internet



Basic router filtering

Don't help flooders

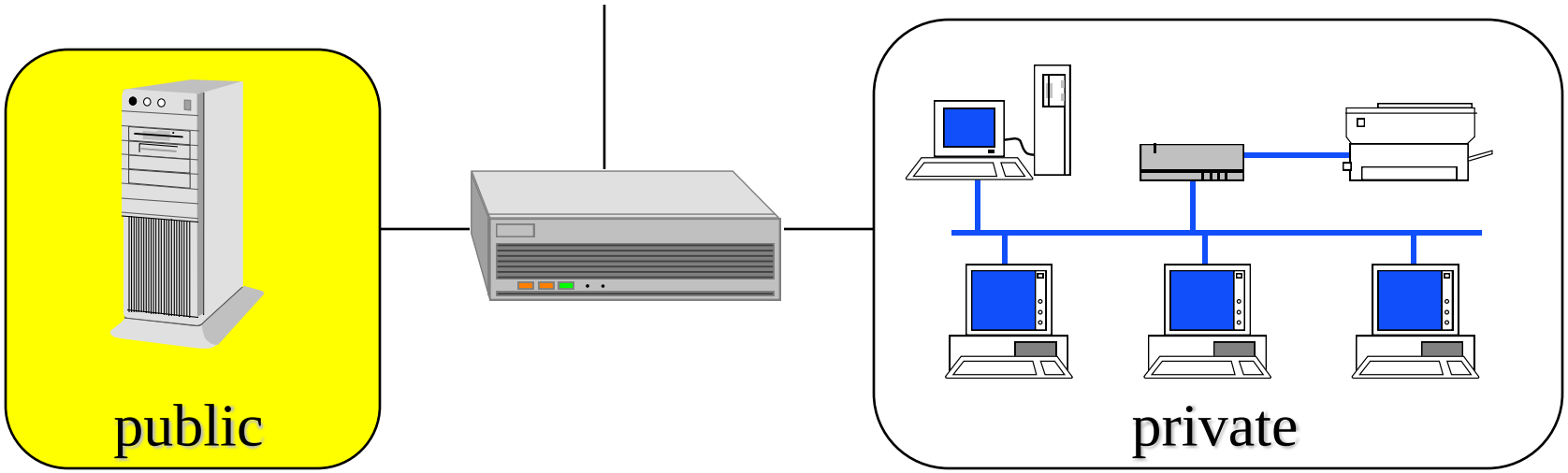
- prevent your network being used as a DoS amplifier



Division of the network

- public segment
  - DNS server
  - public web server
  - mail server (MX record points to it)
- private segment
  - internal web server
  - SMB/NetBIOS shares
  - mail server (retrieves mail from the mail server on the public segment)

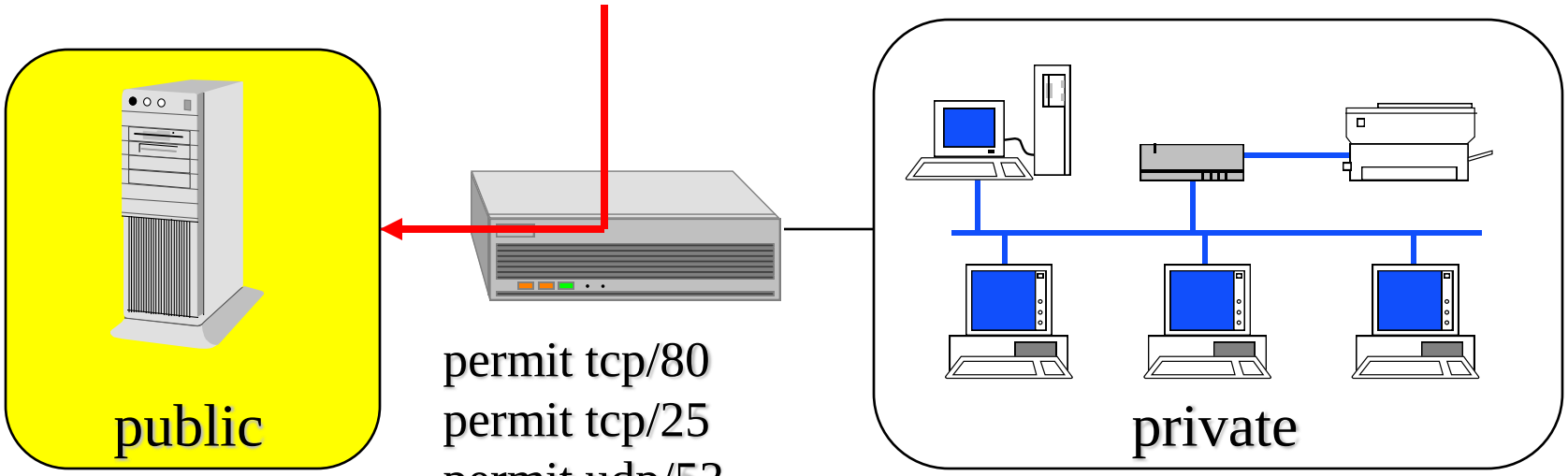
Filtering traffic (1)



web server
email server
DNS server

internal web server
email server
NetBIOS shared disks and printers

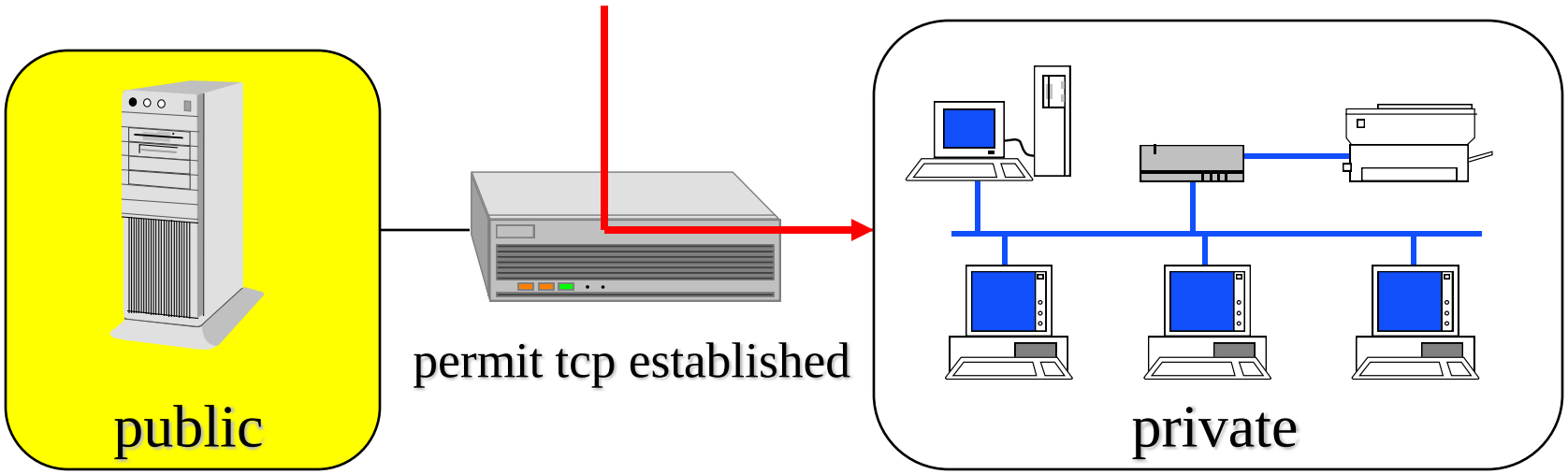
Filtering traffic (2)



web server
email server
DNS server

internal web server
email server
NetBIOS shared disks and printers

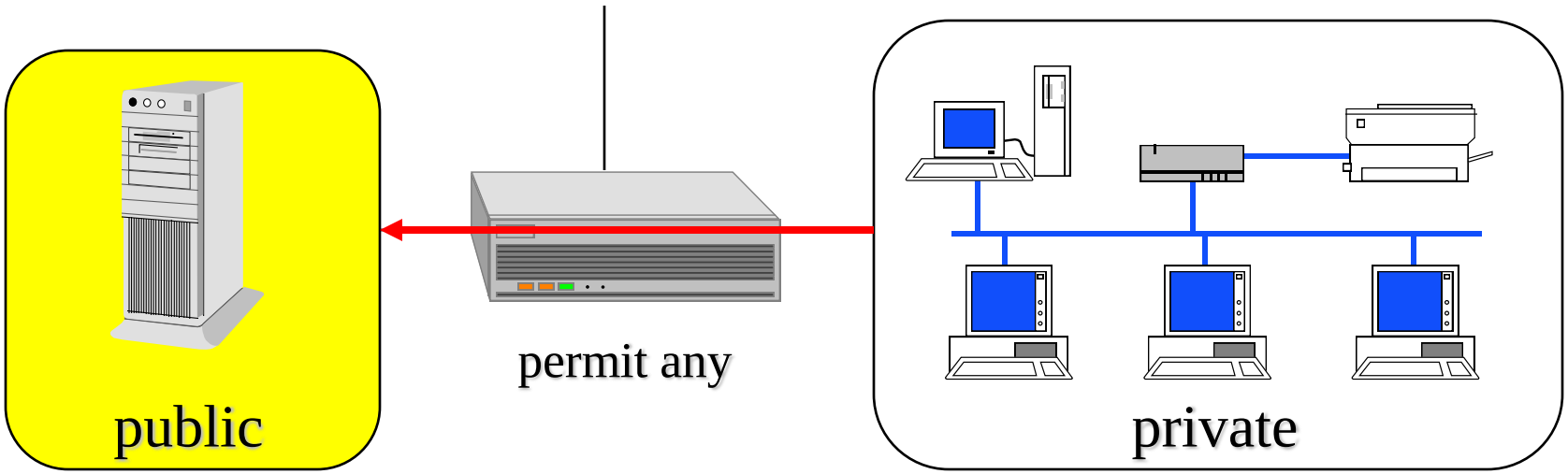
Filtering traffic (3)



web server
email server
DNS server

internal web server
email server
NetBIOS shared disks and printers

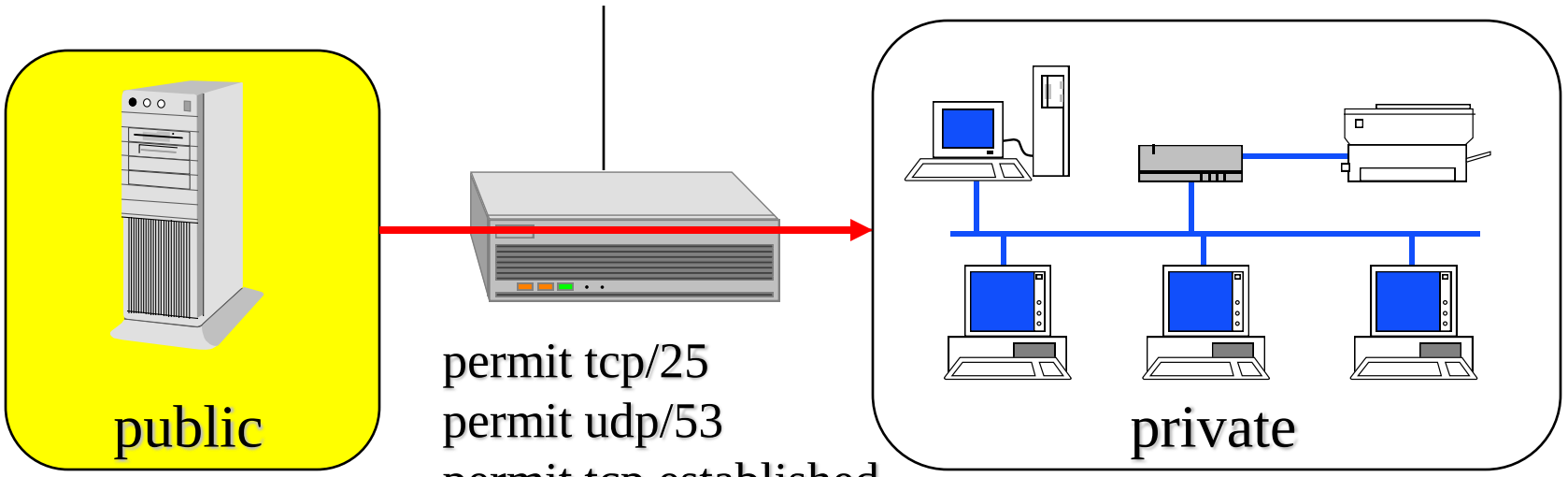
Filtering traffic (4)



web server
email server
DNS server

internal web server
email server
NetBIOS shared disks and printers

Filtering traffic



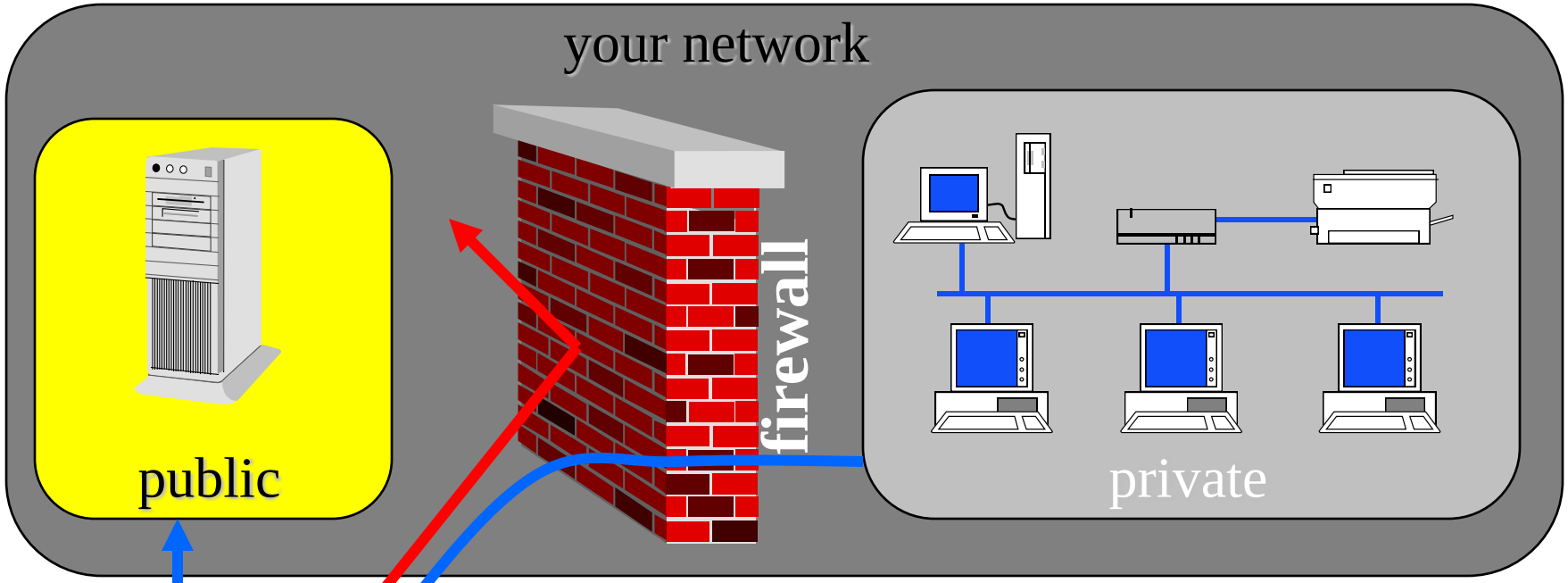
web server
email server
DNS server

internal web server
email server
NetBIOS shared disks and printers

Firewalls

- wide range of products
- features
  - packet filtering
  - stateful inspection
  - application proxies
  - active content filtering and anti-virus protection
  - VPN integration

Implement a firewall



still allows transmission of information from private area into the Internet!

Summary

- In this lecture, we have understood:
  - Multiple Access Control methods
  - ALOHA, CSMA, CSMA/CD
  - Ethernet, LAN topologies, Bridge
  - Basic Network security in LAN

Next Time

- We will know about
  - 802.11 Wireless LAN
  - Bluetooth
  - Cellular Communications
  - Satellite Networks

- Suggested Reading:
  - Chapters 14 and 17 (Stallings)